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UNITED STATES DEPARTMENT OF AGRICULTURE
Research Program Development and Evaluation Staff
Washington, D. C. 20250

+ REPORT AND RECOMMENDATIONS
of the
HORTICULTURAL CROPS RESEARCH ADVISORY COMMITTEE
Developed at its Meeting
February 13-17, 1967, [4th]
McAllen - Weslaco, Texas X

HORTICULTURAL CROPS RESEARCH ADVISORY COMMITTEE

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PREFACE

The fourth meeting of the Horticultural Crops Research Advisory Committee was held at McAllen, Texas, February 13-17, 1967. Lewis M. Hardison and Leon C. Jones were unable to attend. John T. Lesley, Florida Citrus Exchange, Tampa, Florida, attended as a representative of the National Agricultural Research Advisory Committee.

The National Agricultural Research Advisory Committee met with the Horticultural Crops Research Advisory Committee for the opening session on Monday, February 13. Assistant Secretary, George L. Mehren, chairman for both committees, opened the meeting. R. E. Patterson, Dean, College of Agriculture and Director, Agricultural Experiment Station, and W. R. Cowley, Superintendent for Research, Lower Rio Grande Valley Research and Extension Center at Weslaco, and members of the station staff, appeared before the Committee. L. E. Hawkins, Director at Large, represented the Southern Agricultural Experiment Station Directors.

L. G. MacDowell, Secretary, Florida Citrus Commission, spoke on behalf of the Florida Citrus Research Council on priority research needs on citrus in Florida. Written research statements for committee consideration were supplied by the following associations: National Association of Frozen Food Packers; Florida Citrus Commission; National Cannery Association; Nursery Industry; Florist-Nursery Industry; Florists' Transworld Delivery Association; Fresh Peach Industry; National Institute of Locker and Freezer Provisioners; Mid-Atlantic Food Processors Association, Incorporated; Pickle Packers International, Incorporated; Potato Chip Institute; American Seed Research Foundation; and the Sunkist Growers, Incorporated.

The Committee was also provided a review of the administrative and budgetary developments in the Department; a discussion on horticultural crops research in the Lower Rio Grande Valley; tours to the USDA and State research facilities and experimental plots in the area; and discussions by USDA staff on current and projected research programs for horticultural crops.

After careful review of the information available, and based upon current and future need for new knowledge and the seriousness of problems faced by the industry, the Committee made the following comments and recommendations.

GENERAL COMMENTS AND RECOMMENDATIONS

The National Program of Research for Agriculture

The Committee compliments the Department and the State Agricultural Experiment Stations for pioneering a greatly improved analysis and planning system. This enables a far clearer picture of its resources, activities and objectives, and better formulation of projections for the future. Especially gratifying is the view provided by this system of the Department's activities and research emphasis in perspective with the total national effort in agricultural research, including universities, institutes and industry. The Committee feels that it would be of great benefit to its deliberations if it could have an annual view of the broad picture provided by this new system. Also, it suggests that the basic framework of the system be subject to continuing review and improvement to insure that it will serve as a flexible tool rather than a rigid rule.

An Assistant Secretary for Science and Education

The Committee again reaffirms its recommendations that an assistant Secretary of Agriculture for Science and Education be established. The individual selected for this highly essential function must be a scientist of renowned skill and national reputation. The availability of such a recognized scientific spokesman would enhance the prestige of research in agriculture and education in public and private sectors on a national basis, and also within key scientific groups at the Federal level.

Research Facilities for Human Nutrition

The Committee believes that more adequate facilities for human nutrition research are needed if the Department is to implement the recommended expansion of consumer-oriented food and nutrition research contained in the report, "A National Program For Agricultural Research." Thus a recommendation again is made that funds be made available for a central research facility for human nutrition. Our Committee and others have long advocated that the construction and staffing of such a headquarters facility should have the highest priority. Such a facility should be adequate and appropriate to the very important mission of researching the nutrient and food needs of our primary resource -- people.

Restrictions on Travel

The Committee is very concerned because of the restrictions placed upon travel of personnel assigned to various types of agricultural research and development, hence, the Committee recommends that due consideration be given to easing these restrictions. Much field work and supervisory travel is necessary to initiate, evaluate and direct research programs. Restrictions

placed upon travel limit and handicap excellence of work, depth of research and continuity of personnel. We believe "the economies" actually achieved in these travel restrictions are minimal in dollars. They are seriously detrimental to the sound administration and coordination of research and the achievement of desired scientific results.

Public Understanding of Agriculture

Recognition is given to the public and private agencies for prior and present efforts to create a better general public image for agriculture. This Committee, however, recommends that the U. S. Department of Agriculture exercise leadership in a national, sustained effort to create a better public image and understanding of agriculture as it concerns the various publics, including contributions of agriculture to the national economy and the general well-being of the nation. These efforts must be aimed primarily toward the urban segments of the population and nonagricultural phases of our industry.

Salary Increases

The Committee commends the Department for securing and employing the best available scientists to discover solutions to applied and basic problems in agriculture. Currently, industry, foundations, etc., are paying salaries to the most highly skilled scientists far in excess of what can be obtained in the Department. For the purpose of maintaining the highest scientific quality in basic and applied research in agriculture, the Committee recommends salary increases to make them competitive with those of universities and industry.

Basic Research on Bacterial Diseases

The Committee reaffirms its recommendation of last year that a general basic research facility be established for research in phytobacteriology in order to provide a better understanding of bacterial diseases that attack horticultural crops. More information is needed on the nature, action, chemistry, physiology, genetics, taxonomy, and mode of actions of these causal disease agents. Because of the shortage of scientists in this field, additional emphasis should be placed on graduate training of research specialists in this field.

Increased Support for Virus Research

Virus diseases are among the chief limitations to further improvement in yield and quality of many of our horticultural crops. Once a virus disease has become established in a plant, there is little opportunity to cure the plant of the disease. Our Committee urges increased support and expansion of research on virus diseases of horticultural crops, with emphasis on the

nature and mechanism of disease damage to plants which could provide information to control or cure infected plants either by chemical, physical, or biological means. The Committee further recommends that these expanded programs be so designed to afford maximum support of graduate training of research specialists in this field.

Isolation Laboratory for Plant Pests

The Committee recommends the establishment of an isolated laboratory for the study of plant pathogens nonindigenous to the United States mainland. The control of many potentially destructive diseases of the United States horticultural industry are little understood because of the inability to study the organisms under present quarantine restrictions. Further, some pathogens now present on the mainland may or may not be representative of other and more destructive variants of the same organism prevalent in nondomestic segments of the horticultural industry. Study of such organisms needs to be conducted in an off-shore facility to insure safety and aid in ease of procuring and working with the materials. Rigid controls on movement of personnel and materials, especially to the mainland, would be required. To adequately meet these conditions, and provide a widely ranging study of horticultural pests, the facility must be located with care and receive adequate support for its functioning.

Biosystematics Research Facility

Knowledge of the identity, range of variability, and relationship of insects, fungi, nematodes and bacteria is essential to research and regulatory programs. The Department now has cooperative classification studies with the Smithsonian Institute on fungi and insects. The Department has some research on the taxonomy of bacteria. We recommend that the Department explore thoroughly with the Smithsonian Institute, the possibility of a joint research facility and that appropriations be obtained for this facility. This facility should have laboratories and greenhouses for investigations on the relation and variability of plant pest organisms, i. e., fungi, insects, bacteria and nematodes. Provision should be made for adequate facilities to house the national collections of these organisms.

Need for an Institute of Biological Science

The United States Department of Agriculture has already made many outstanding basic contributions to an understanding of biological phenomena. These contributions have lead not only to the development of more efficient agriculture but to improved human welfare. However, the Department should become even more aggressive in leading the world in investigations leading to the development of basic scientific knowledge. The Committee strongly recommends that an Institute of Biological Science, under the direction of the United States Department of Agriculture, be established for this purpose and that studies be made toward the goals of acquiring deeper insight into the basic mechanisms of genetic inheritance, and the processes of reproduction, growth, maturation and senescence in plants.

Fellowships and Training Grants

The Committee is impressed with the importance to agriculture and to the nation of having an adequate supply and quality of scientists to meet the provocative long range goals and projections for agricultural research. In many disciplines there is already a serious shortage of agriculture-oriented scientists, and this is likely to become even more critical in the years ahead. There are many opportunities for adequately trained young men in the diverse aspects of modern agriculture. There is need to bring the challenge and rewards of a career in agriculture and its related sciences to the attention of the youth who are still seeking their life's work. The image of agriculture can and must be presented more dynamically in our universities, and fellowships and training grants under USDA sponsorship can be one such device. The Department does not presently have the legal authority that other government agencies have long had to develop a cadre of new young scientists through a flexible graduate fellowship and training grant program. We strongly urge that such authority and adequate funding be sought by the Department.

Effects of Environmental Pollutants on Yield and Quality of Horticultural Crops

The Committee wishes to compliment the USDA for adding \$449,000 to its budget for research in this all-important field. However, we feel that support for environmental pollution research is still far from being adequate. Air pollution is now recognized as a rapidly growing national problem with horticultural crop losses occurring particularly in the high-value, intensive farming areas close to centers in which industrialization and urbanization is expanding rapidly. If research on this problem is not prosecuted on a scale commensurate with its menace, it will ultimately seriously blight not only our food and fiber producing potential but our health and well-being and our future as a nation.

Research Coordination

The Committee urges more cooperation and coordination between various research divisions in the development of product varieties, and handling methods - that quality specialists be teamed with engineers - in order to assure better quality maintenance and acceptance in the market place.

Marketing Research

Efforts should be made to acquaint horticultural commodity groups with the programs which are available and being used by other commodity groups in foreign market development work and assist in the implementation of such programs.

Fresh and Processed Grades and Standards

The Committee urges that consumer preferences on individual commodities as indicated by market studies be the basis for recommending changes in grades and standards for that commodity. These changes should more realistically and practically maintain quality levels for fresh and processed horticultural crops based on technological advances and changes in marketing patterns or consumer shopping habits.

COMMENTS AND RECOMMENDATIONS ON CURRENT PROGRAM AND NEEDED RESEARCH

In recommending new or expanded research on problems listed in this section, the Committee recognizes that it is not its responsibility to delineate between research to be conducted within the Department and that to be conducted in cooperation with State Agricultural Experiment Stations and other research organizations. The recommendations made by the Committee are based on their judgment that the problems are important and that research is needed on them. The Committee did not attempt to establish priorities as to importance of problems recommended except to point out special problems that needed immediate attention.

FARM RESEARCH

Physiological Studies

The Committee recommends that additional investigations be made on the physiology of nursery stock, fruits and nuts, with specific investigations, where applicable, into factors affecting fruit set, fruit uniformity and fruit harvesting, including the use of growth regulators, other synthetics and natural growth substances, temperature tolerance, transpiration, translocation and the fate of chemicals in the plant. Where fruit studies are involved, specific attention should be paid to, but not limited to factors affecting induction and/or breaking of dormancy, abscission, and the effect of enzymes on the changes in color, flavor, aroma and texture of processed products.

Investigations Related to Plant Tolerance

Isolated examples of horticultural plant tolerance to cold, heat, salinity, and water stress are known but little understood. Investigations of stress physiology of horticultural crops have generally been limited to descriptions of plant response. Modern biochemical and metabolic research related to stress physiology are limited and have only recently been initiated. The Committee recommends that basic research in this area be increased in order to gain an understanding of the physiology of stress in horticultural plants as well as to develop new methods of assessing plant tolerance to stress.

Growth Regulator Research

Greater emphasis should be placed on the development of growth regulators to control the size and shape of plants in the horticultural crops groups. The potential use of these chemicals for controlling plant development and size may be especially important as mechanization develops in vegetable production, or to regulate growth of trees and shrubs for landscape and garden purposes.

Cytoplasmic Male Sterility

At the present time the basis for the successful production of hybrid onions is the use of cytoplasmic male sterile character. Production in many other hybrid crops such as carrots, broccoli, and cabbage, is limited because a workable system of cytoplasmic male sterility has not yet been developed. There is a great need to develop an understanding of the nature of the unknown entity carried in the maternal cytoplasm to provide reliable means of production of hybrid vegetables.

Tolerance to Air, Soil and Water Pollutants

There is an urgent need for research to overcome the problems resulting from air, soil, and water pollutants. Special emphasis should be directed to the introduction of new or the development of plants for highway and urban beautification and to horticultural types grown in areas in which urbanization and industrialization is rapidly expanding.

Research on Peaches

Because peach varieties are somewhat locally adapted, State programs must be continued and USDA programs should be expanded. Specific variety needs include (a) greatly improved early varieties for southern areas, (b) improved winter hardiness for all northern areas, (c) expanded programs in breeding for processing needs, (d) nomenclature - other than by variety.

Peach rootstock improvement should be expanded in order to increase production and lower costs. This should include research on the relationship of rootstocks to nematodes, soil fertility practices, winter hardiness, needs and availability of soil moisture, and cover crops in regions of low snow fall.

Canker in peaches is a serious problem in the North. In many areas its relationship to winter hardiness is more closely associated with low production of peach orchards than any other problem. Greatly expanded research programs are needed to determine methods of reducing susceptibility of peach trees to cold injury and combatting various cankers. These should include (a) training and pruning, (b) nutrition, (c) insect and disease control, (d) weed control. Special cankers are (a) Valsa, particularly in Michigan, New York and Canada, (b) Fusicoccum.

Potatoes for Processing

Greater emphasis should be placed on the development of potato varieties with specific qualities for use in processing. These specific qualities should include, in addition to good color retention during processing, (1) inherent low sugar content, (2) long dormancy, (3) good storageability, (4) disease resistance, (5) high yielding ability, and the capability to withstand bruising when handled at harvest time.

Additional research should be devoted to studies on enzyme systems, to changes in sugar content and changes in nitrogenous fractions as these items relate to potatoes stored under various environmental conditions (especially at relatively high temperatures).

Onion and Carrot Seed Production

Special emphasis is needed to determine cause and causes contributing to low yields of onion and carrot seed. This should include research on cultural and genetic schemes to economically produce seed of new hybrids.

Work on the development of carrot breeding lines resistant to aster yellows and Cercospora blight should be restored.

Cucumbers

There is a need to develop improved varieties of pickling cucumbers better adapted to mechanical harvesting, storage and brining.

Tomato Varieties

Increased emphasis should be placed on the development of multiple disease resistant tomato varieties for mechanical harvesting. Special attention should be paid to firmness, color, total solids, easy detachment, uniformity of maturity, early maturity, size of core, and other characteristics necessary for tomato processing, including enzyme systems operative in degradation of flesh texture, influences of temperature and humidity, and nutritive values.

Lima Bean Research

Poor germination and nonuniform emergence of Fordhook lima beans have always been major problems for growers. With the trend toward mechanical harvesting the need for research to improve germination and uniform plant emergence becomes much more acute.

Bacterial Diseases of Beans and Tomatoes

Research should be intensified on bacterial diseases of beans and tomatoes that are caused by seed-borne pathogens, including mechanisms of transfer; the extent of natural nonsystemic and systemic persistence of the bacteria;

the environmental conditions required to consistently develop typical infection; methods to accurately and reliably evaluate the relative host susceptibility; and methods for controlling the seed-borne bacterial diseases of beans and tomatoes. The results from these studies should serve as a basis for similar programs with other vegetables.

Lettuce

Research should be initiated immediately on the physiology of lettuce seed maturation, storage capabilities, and germination to insure uniformity of plant emergence and subsequent growth. Cultural practices, including seedbed preparation, seeding methods and rates of seeding, nutrition under varied production environments, thinning methods, and techniques to determine head maturity in relation to mechanization of the harvest should be thoroughly investigated using an interdisciplinary approach to solving the problem.

The magnitude of research on the development of male sterile lines for use in developing lettuce F₁ hybrids should be increased to include research in cytogenetics and pathology to improve the efficiency of this approach in developing lettuce varieties adapted to mechanical harvest under different production environments.

Additional research is needed to fully exploit resistance to lettuce mosaic, search for new and better sources of resistance, and search for resistance to the new race of lettuce mildew that has recently appeared in Texas.

Melons

Research should be initiated to identify the agents responsible for the deterioration of the root system of cantaloupes. Investigations should include viruses, pathogenic microorganisms, fungi, salt concentration in soil and in irrigation water, irrigation timing and rates of application. Environmental studies should be initiated to determine the role of air pollutants, rapid changes in temperature and humidity inherent in a desert irrigated atmosphere and irrigation practices on the metabolism and water economy of the cantaloupe plant. Research should be expanded on the development of high quality, multiple disease resistant cantaloupes adaptable to mechanical harvesting and relatively inexpensive to field hybridize. The development of disease-resistant, particularly virus-resistant cantaloupe varieties, and a program of research as indicated, would materially aid in the development of crown blight-resistant cantaloupe varieties.

Edible Legumes

Edible legumes, including Azuki bean, dry beans, peas, pigeon peas, lentils and chick peas, are a primary source of protein in under-developed countries of the Near East and dry beans are almost the sole source of protein in Latin America. Most pulses contain from 20-25 percent protein. Protein and amino acid determinations (quantity and quality) of present grown pulses should be made which will aid in the selection of parental material for breeding to

increase the quantity and quality of newly developed varieties of these crops. These varieties should also resist important diseases and if possible, insect pests to assure production. Since the United States exports large quantities of many of the above legumes, an increase in the percentage and quality of protein in the exported pulse crops would improve their food value where protein shortages exist.

Root Rot Diseases in Vegetable Legumes

Urbanization and labor costs are compelling intensification of land use to continuous cropping systems for the major vegetable crops used in processing, thereby accentuating root rots and other disease problems. The vegetable legumes are especially sensitive and susceptible. Research to find and incorporate genetic resistance or develop chemical and/or cultural control measures of root diseases of vegetable legumes should be increased and coordinated.

Hybrid Vegetable Seed Production

The capability to create hybrids in many major vegetable crops and their potential value in increased uniformity and yield have been established. Unfortunately the genetic systems used to create these hybrids were developed in greenhouses or on a small plot basis and often outside the western seed production areas. These materials, therefore, do not perform reliably in seed production fields. Research should be undertaken to develop cultural and, if appropriate, genetic schemes for the economic production of seed of new vegetable hybrids.

Cultural Systems for Mechanical Harvested Crops

The use of mechanical harvesters is present or imminent for all vegetable crops and precedes the investigation and development of suitable cultural systems to produce vegetable crops for such devices. Entirely new requirements have been imposed on every aspect of culture of each of the crops involved. Research is needed which takes into consideration all aspects and implications of varieties and culture (precision seeding; plant stands and row spacing; growth regulators; fertilizers; weed, insect and disease control; the maintenance of planting and harvesting schedules) as a unified cultural system.

Handling and Storage of Nursery Stock

Improved methods are needed for handling, transporting, and storing nursery stock in order to reduce labor costs and to provide the consumer with healthy, viable plants. Research should be initiated on the storage and handling of nursery stock with bare roots (without earth balls). Investigations should include studies on controlled atmospheric storage; on methods to

reduce root dessication, etiolation and fungus development in storage; and the development of anti-dessicants. Concurrently, investigations should include methods for storing fall dug, balled or container grown plants in the colder regions, for holding for spring delivery.

Plant Propagation

Research is needed to develop techniques for propagating hard-to-propagate plants desirable for landscape use. These studies should include Myrica cerifera, Sabel palmetto, and Kalmina latifolia, all native to the United States. Difficulties have also been experienced with Prunus cistera and Prunus glandulosa, with some indication that plants from these genera are difficult to propagate if infected with a virus.

Windbreaks

There is increasing evidence that farm windbreaks can be either beneficial or harmful to yields of nearby crop plants depending upon their nature. There are many thousand miles of windbreaks planted each year with insufficient knowledge of what their effect will be on nearby crops. It is urged that research be greatly expanded in order to conserve properly soil and moisture to the greatest extent.

Interaction of Chemicals in the Soil

The Committee recommends that research be rapidly expanded to investigate the interrelationships and interactions of the various chemicals that accumulate in the soil as a result of the continued application of herbicides, nematocides, insecticides, fungicides, fertilizers and other chemicals to the soil or to the above ground portions of fruit, nut, nursery, and other perennial horticultural plants. It is highly possible the cumulative effects on the plant, resulting from the continuous application of many kinds of chemicals, may eventually result in reduced vigor or even death of the plant. At the same time, the land may be made unfit for the propagation of other crops. A rapid method is needed immediately for assaying our soils to measure the build-up of the chemical residues in the many soil types.

Weed Control

Because of acute labor shortages, chemical residue problems and the need for clean fields for mechanical harvesting of horticultural crops, weed research in this area must be expanded. The research should include additional fundamental studies on the morphological, physiological and biochemical effects of continued and frequent applications of herbicides on vegetables and on long-term, annual applications of herbicides of perennial crops, including fruit and nut crops, ornamental woody plants, small fruits and asparagus, and on the persistence, degradation and movement of the herbicides in the associated soils and drainage water. Research on the principles of control of perennial weeds in the above crops is also needed.

Container grown plants require special use of herbicides due to the limited amount of growing medium and frequent watering. Expansion of the present program is recommended to develop a method of controlling weeds and grasses for period of seven months and as long as two years. More simple, yet precise methods of application of these chemicals needs to be devised.

Nematode Control

Interdisciplinary research is needed between nematologists, plant pathologists, and plant breeders to evaluate and develop resistant or tolerant plants to many types of nematodes other than the common root-knot nematode. Nematode problems are virtually unsolved on melons, small fruit, peppers, squash, cucumbers, cabbage and related crops, onions, garlic, fruit and nut trees. In addition to plant breeding programs, greater emphasis should be placed on developing practical control by chemical and cultural means for vegetable crops.

New research should be undertaken to determine the extensiveness of inter-relationships of nematodes with other organisms such as viruses, fungi, and bacteria.

Increasing inter- and intrastate shipment regulations of nematode-infected ornamental, fruit, nut, and shade-tree crops and reduced production caused by many nematode types requires immediate attention to determine sources of resistance, and the need to develop chemical and cultural means of controlling nematodes in soil and roots, especially in nursery materials. Nematology research on ornamentals and shade trees is of great concern to producers in all areas of the country.

Insect Control

Chemical insecticides and pesticides on which the industry greatly relies on at present for crop protection contribute to the problem on environmental pollution and human health hazards. Safer and more effective chemicals need to be developed and made available with utmost speed.

The Committee recognizes and applauds the value and the excellent quality of the research presently being done in the field of biological control and by means of male sterility, sex attractants and other new approaches. Present programs need to be broadened to cover insects on all major horticultural crops, ornamentals and turf.

Of specific importance to the Northeast, is the European chafer (Amphimallon majalis, Razoumowski), an imported insect which was introduced into western New York in the 1920's. This insect is spreading rapidly into adjacent states, threatening turf, forage, and grain crops. Improved detection techniques as well as new control methods are needed if this pest is to be eradicated from the infested areas of the Northeast and prevented from spreading into the highly productive central agricultural production areas of the country.

Research on the control of insects in citrus and deciduous fruits by the use of sex attractants, systemic insecticides applied to soil surface or incorporated into the soil, or by the use of sex attractants plus male sterility techniques needs to be greatly expanded.

Mechanization Research

The ability to maintain an adequate food supply of high quality for the consumers of our nation is increasingly hampered by the lack of competent farm labor. The critical farm labor supply problem, particularly as it pertains to harvesting labor, has created a most urgent demand for an expanded research program into the agricultural engineering techniques. We cannot overemphasize the need, time is of the essence, for development of practical devices and systems starting with the seed and the seed bed, to plant, grow, harvest, transport, process, package, and deliver our horticultural crops on a quality basis. Mechanical harvesting demands precision planting. Precision planting demands a whole new look into the development of new improved varieties of all horticultural crops. The Committee recommends research be accelerated in the development of new and better methods of harvesting and handling horticultural crops.

Vegetable Planting Methods and Equipment

Very little, if any, research is being done on seed and seedbed requirements of vegetables. These requirements are quite different from those of field crops. While equipment is available commercially for planting vegetables, this equipment falls short of meeting the optimum planting requirements for many vegetables. Hence, research should be initiated to develop equipment which will plant vegetable seeds precisely, and which will control the soil aggregate size and compaction surrounding the seed for maximum uniform emergence. Uniformity of emergence is a prerequisite to uniform maturity and thus it is important to efficient mechanical harvesting. Plant breeders believe they can assure good predictability of emergence if optimum uniform planting conditions are obtained. It is also necessary to devise equipment for proper uses of herbicides, fertilizer and systemic pesticides that can be used concurrently or attached to planting equipment.

Vegetable Harvesting Equipment

With many vegetable crops, harvesting constitutes the most costly operation and the greatest number of man hours expended for the overall production outlay. In addition, the large supply of labor necessary to perform this job is unreliable and strict supervision is necessary to attain acceptable standards. Moreover, it has been shown in many instances, if the plant characteristics and growing habits necessary for successful mechanical harvesting are known, plant breeders can often meet these requirements. Such advancement can only be gained by close mutual cooperation and investigation between these and other groups. A rather substantial program on vegetable harvesting research is needed in light of the increasing costs

and scarcity of hand labor. While a substantial amount of work should be directed to completely mechanizing the production and harvesting procedures for all types of vegetables, major effort should be devoted to fundamental studies of methods for mechanical detachment, separation, and conveying of vegetables to serve as a basis for applied research on harvesting. Again this shows the great need for a complete system and research cooperation between agricultural engineers, horticulturists, and plant physiologists.

Protection of Fruit Trees From Frost Damage

Research to protect tree fruits from frost damage should be intensified and a thorough investigation of orchard heating techniques and equipment should be made.

Mechanical Harvesting of Fruit and Nut Crops

Much progress has been made in mechanizing the harvest of fruits for processing outlets, but little progress has been made on selectively harvesting fruits for fresh market where bruising cannot be tolerated. The shake-and-drop principle cannot be used on certain fruits due to their high susceptibility to bruising even though the fruit may be processed. New concepts of mechanically selecting and detaching fruit from trees, canes, and vines are urgently needed with specific attention being given to peaches, pears, and grapes. The prospect of expanding the production of certain nut crops will be dependent to a considerable extent upon the development of effective methods and equipment for harvesting and farm operation. Specific and immediate attention should be given to the pecan crop.

Processing of Vegetable and Flower Seeds

Vegetable and flower seeds are an important segment of the United States' 750 million dollar a year seed industry. These seeds are typically irregular in shape, size, density, and other physical characteristics which make them difficult to handle with conventional harvesting and processing equipment. High handling costs of relatively small volumes has forced this branch of the seed industry to remain primarily a hand operation. With the curtailment of the importation of Mexican labor and the increases in other costs, producers and processors of vegetable and flower seeds are in serious trouble and need help in solving their harvesting and processing problems. Preliminary research has shown that many techniques and machines used for grass and legume crops could be readily adapted to vegetable and flower seeds. For example, the vibrator seed separator will remove dodder from carrots, barnyard grass from onions, pigweed from alyssum and asters, as well as cone pieces and other trash from zinnia seed. Also needed are techniques and machines for determining the size and shape of screens or length of separators and the use of seed moisture as an index to determine the proper time to harvest seed for maximum yield and quality.

NUTRITION, CONSUMER AND INDUSTRIAL USE RESEARCH

Centralized Human Nutrition Research Headquarters

The Committee notes with regret that once again the Department's budget request has not included funds for new and improved facilities for human nutrition research. This area of study is a vital part of agriculture as it relates to the well-being of our human resources. The high priority for such research in the long range plans of the Department points to the urgency of providing a central headquarters building which can improve nutrition research capabilities and coordination, and which will enable studies with human subjects not possible in the several facilities now available.

Basic Nutrition Research

The Committee commends the nutritionists in the Department for their forward-looking studies on interrelationships of food components in the long term health and well-being of the individual. We remain keenly interested in the productive research on the nutritional role of individual carbohydrates, which appears to involve both fat and mineral metabolism. The possible implications of these early observations need to be explored and expanded on an urgent basis. We are pleased to note that current budget increases now before the Congress include a substantial expansion for human nutrition research. The Committee gives strong support to this request for increased funds and staff. The long range targets and manpower projections for basic and applied human nutrition research seem minimal, and should be implemented as agriculture's budgets are developed.

Taste Perception and Food Preferences

The Committee is keenly interested in the practical usefulness of basic flavor research on physiological relationships in taste responses. Knowledge of the manner by which sensory responses of individuals of various ages and genetic background affect food likes or prejudices can be very valuable in developing improved food products and food habits. We urge that research be initiated at a support level adequate to develop the needed information relating taste perception and response to specific food flavor components to food habits and preferences of individuals.

Quality Protection in Quantity Food Service

Last year the Committee called attention to the need for a strong program of research to assure the safety and satisfaction of meals in quantity food service. Since approximately one-sixth of all meals are eaten away from the home, the problems of the centralized food services in assuring maximum eating quality, microbial safety, and nutritional value differ from problems of consumer use of foods in the home. The Committee notes that it has not been possible as yet to implement our recommendation for research in depth in this area. We reiterate our hope that such a program can be developed.

Nutrient Analysis of Horticultural Crops

There is need for greater emphasis on analysis to determine the nutrient contribution of fruits and vegetables and their processed forms. New products, new varieties, new processes, and new production and marketing and preparation practices lead to important gaps in our knowledge of nutrients in our food supply. For some, such as the trace mineral elements, data are very scarce. For many nutrients, analyses do not reflect the biological availability and hence the true nutritional contribution of a commodity. A broad program of food analysis can backstop the urgent program of basic nutrition research. It deserves strong support.

Food Composition Tables

The Committee recognizes that reliable data on the content of nutrients in foods are essential for the nutritional assessment of foods, food supplies, and diets and that the tables of food composition of the Department make a unique contribution to nutrition programs. The work needed for periodic revisions of these tables of food composition should be continued. As soon as time and funds permit this work should be expanded to include all new data on the content of important nutrients if changes in content are introduced by the development of new varieties or that result from new production or processing practices.

The Committee is pleased to note that work has been initiated on the revision and expansion of the data in the tables on the amino acid content of foods, Home Economics Research Report No. 4 "Amino acid content of foods," 1957 and that early release is planned for the data on the content of amino acids in fruits and vegetables. These data are urgently needed for planning diets used in the treatment of certain disorders of amino acid metabolism.

Diets and Food Habits of Children.

The Committee recognizes that effective guidance for improving children's food habits requires supplementing information on food practices by a knowledge of the factors that will bring about desired changes. The Committee recommends that a pilot study be made to investigate the components of food habits and to identify the most effective procedures for improvement. It also recommends that a study be made to provide information on the diets and nutritional status of preadolescent children and that information be obtained on those socioeconomic and food management factors that are believed to be closely related to nutritional status.

Food Consumption Survey Data

The Committee urges that release of findings from the nationwide food consumption survey 1965-1966 be expedited to make the results of this survey available as soon as possible for the benefit of those in industry, professional groups and others who need the detailed information in their current programs and plans.

Utilization Research Staff and Facilities

The provision of adequate staff and equipment for all utilization research laboratory space now existent, or for which construction has already been funded, is most urgently recommended to make certain that such laboratories will be effectively and efficiently used to carry forward the important and needed research to build new markets for horticultural crops.

Chemistry and Physical Properties

To provide a basis for the development of new and improved processed products and the improvement of processing technology, a more detailed knowledge of the chemistry of fruits, vegetables, and tree nuts is essential. Research should be expanded on major and minor components, the structure and properties, and changes that occur during and subsequent to processing of these crops.

New and Improved Processed Foods

A continuing adequate supply of fruits and vegetables depends more and more on preserving them and making new and improved products. Dehydrated products of low volume and weight offer relief from mounting distributing costs. Consumers demand variety, novelty, convenience, and minimum cost. Export markets, particularly for concentrated and dehydrated products that are inexpensive to ship, can be developed in countries where economic conditions are improving. Tree counts showing huge acreages of still nonbearing trees, indicate a future increase in fruit production beyond population growth and emphasizes the need for products that can compete in international trade. We recommend expansion of research coordinated with marketing research to develop commercial use of promising experimental products; to develop additional new and improved products from horticultural crops and to devise means to use more effectively processing grade fruits and vegetables.

Processing Mechanically Harvested Fruits and Vegetables

High cost and decreasing availability of labor is accelerating the trend towards mechanical harvesting of fruits and vegetables. Machine-harvested fruits and vegetables often do not have the uniformity and freedom from bruising that was obtained by experienced harvesters. Sometimes over- and under-mature raw material, excessive trash and dirt, and increased contamination are by-products of machine harvest. Greatly expanded coordinated research is urgently needed to minimize the impact of mechanical harvesting of fruits and vegetables on yield and quality of the processed product in order to place mechanical harvesting of these commodities on a sound practical basis.

Market Testing New Products

Research should be expanded to determine market possibilities and economic feasibility of new consumer products developed by the Utilization Research and Development Division laboratories in order to advance them into commercialization.

Improved Processing Methods and Equipment

Food processing methods must continuously be evaluated in the light of new technical developments, to reduce costs and improve product quality. Basic research to develop new principles, and applied research to take advantage of technological innovation should both be expanded. These should include methods of retaining and improving color, texture and serving convenience of canned, fermented, frozen, dried and concentrated products; means of making uniform high-quality products from variable raw material; new ways of drying, concentrating, and preserving fruits and vegetables; and development of means of controlling quality during processing operations.

Expanded Cooperation Between Utilization, Marketing and Production Research

We recommend that cooperative research be expanded by utilization research scientists with plant breeders, agronomists, engineers, horticulturists, marketing specialists, and others who develop new varieties, harvesting equipment, and improved growing, handling and storage practices to evaluate processing handling, storing, nutrition and eating quality before new varieties are released or new growing or harvesting methods are extended to commercial farming. This type of work should be done at or near field locations so that materials used will be equivalent to raw material entering the marketing system.

Microbiology of Raw Material, Equipment and Processed Products

Research should be expanded to prevent or reduce the microbial contamination in raw materials for processed foods; and to attenuate, eliminate or otherwise control spoilage, toxin-forming, and disease-producing microorganisms in preprocessing and processing steps, and in equipment and manufactured food products. This should be accomplished with minimum deterioration of processed product characteristics.

Waste Disposal

Disposal of processing wastes from agricultural products is a problem of agriculture and needs increased attention. Research should include modification of present processing operations and the development of new methods of processing fruits and vegetables so the waste effluent will cause minimum contamination of the environment. A consideration of any new processing method developed by the Department must include the minimizing of disposal problems.

MARKETING AND ECONOMIC RESEARCH

Packaging and Handling of Horticultural Crops

There is a need for expanded research in the field of packaging for all horticultural crops. This research should encompass all phases of packaging from producer to consumer.

Foreign Market Laboratory

Export outlets for fruits and vegetables are essential to the expanding U. S. industry. While apple and certain citrus fruit markets are well established, there is increasing European interest in all horticultural crops from this country. The condition of these commodities in the European market will largely determine the development of this outlet. Funds should be provided to establish a market laboratory in Western Europe for intensive evaluation of all American-grown fruits and vegetables as they move through wholesale and retail markets, for developing improved handling methods at overseas markets, and for receiving and evaluating test shipments by U. S. research workers.

Mexican Import Situation

The Committee reemphasizes the 1966 recommendation to evaluate the Mexican fruit and vegetable production and marketing potential including the possible impact of additional imports on producers, shippers, processors, and marketing firms.

Effects of Mechanical Harvesting on Market Quality

A critical factor in the use of mechanical harvesters on horticultural crops is the development of postharvest decay and the effects on the shelf-life of the product in the fresh market. Research should be initiated to evaluate the effect of available mechanized harvesting equipment on product quality, to reduce adverse effects on the commodity, and to develop methods for reducing postharvest decay and other quality factors in such products.

Effects of Seasonal Factors on Maturity and Storage Quality of Fresh Fruits

The Committee urges continuation and expansion of the study of seasonal factors on maturity and storage quality of fresh fruits. Factors such as bloom date, temperatures at critical periods of crop growth, amount of sunlight and perhaps chemical spray materials appear to affect the harvest maturity, market quality, and storage life of many fruits. Research should be expanded for an intensive study of seasonal factors influencing fruit quality and of the possible role of growth regulating chemicals in modifying postharvest fruit quality.

Vitality of Fresh Horticultural Products

Producers, distributors, and customers know that the storage period and shelf-life of fruits, vegetables, and cut flowers may vary from season to season, between regions and among producers. Climatic, cultural, or other preharvest factors including variety may have a strong influence on the rate of aging or senescence of the product once it is harvested. The Committee recommends an acceleration in basic research on the nature and mechanisms of senescence of harvested plant products. Its scope should

encompass histological and biophysical approaches as well as biochemical and physiological aspects. Hopefully, a greater insight into the aging process would provide tools to slow down this process by the application of improved cultural practices or by new chemical, physical or other approaches. Also, such research may ultimately provide simple objective tests for predicting shelf or storage life and/or susceptibility to invasion by fungi or other organisms.

Studies for Export Transit of Fruits and Vegetables

Research should be continued and expanded in cooperation with the Transportation and Facilities Research Division to explore and develop improved handling methods and to provide optimum transit environments for maximum protection of quality of horticultural crops. Strong efforts should be made to standardize containers and coordinate with importing countries.

Control of Infestation in Unprocessed Commodities

Additional research is needed to develop new or improved materials and methods for dealing with: (a) insect infestation existing in unprocessed dried fruits and tree nuts when brought from the field into storage, (b) infestation of unprocessed commodities in farm and commercial storage, and (c) miscellaneous flying insects and insects attracted from the field to storage, dehydrating, shelling, processing, and packaging areas. The research must be broad enough in scope to include not only studies with new chemicals and application methods but also with several types of potential biological or physical control measures that would avoid chemical residues.

Bulk Transport of Potatoes

In 1966 the Committee recommended work be done on the bulk transport of potatoes. It is strongly recommended that this problem receive immediate attention. Huge quantities of potatoes now move directly from field or storage to processor or repackers who distribute consumer packages to retailers. Bulk movement of this part of the crop appears advantageous when equipment and methods of handling are available. Research should be resumed to evaluate bulk handling of tubers by rail and truck from the standpoint of physical damage to the tubers, protection from heat and cold, and wastage from decay and physiological disorders. Bruising of the tuber during handling and storage causes severe economic losses.

Controlled Atmosphere Storage for Cut Flowers and Propagating Material

Evidence exists that survival rate, growth rate and flowering period of certain cut flowers, bulbs, tubers, corms, cuttings, hardy ornamentals and roots are affected by composition of the atmosphere in which they are stored. Research should be expanded to determine the effects of storage in different partial pressures of oxygen, nitrogen, and carbon dioxide at several temperatures and to compare responses with comparable material stored in air. Prompt action is of vital importance to the florist and nursery industry.

Marketing of Horticultural Specialty Crops

The Committee reaffirms its comments and recommendations of the past three years that the Department strengthen its economic and marketing research with appropriated funds on a continuing basis. The growing volume and the unknown potential for marketing flowering, foliage, ornamental, nursery products and bulbs through mass markets points up the need for more specific research on packaging, storage, transportation, and sources of supply.

Improved Methods, Equipment, and Facilities for Handling, Storage, and Packing Fresh and Processed Foods

In recent years, problems at both the processing plant and the fresh fruit packinghouse have been intensified by the development and wide-spread adoption by growers of mechanical harvesting methods, including tree shakers and mechanical loaders. These methods have speeded up the harvesting of "soft" fruits and reduced the duration of the harvest period. Although California is the largest producer of soft fruits, such as apricots, plums, nectarines, grapes, peaches, and cherries, no research is underway in this area to improve the operations of packinghouses, other than the development of new containers. Nor has research been done on the methods, equipment, and facilities used at processing plants in connection with handling, conditioning, and storage of the commodities before and after processing. It is proposed that research in this area be initiated immediately.

Air Transport

Recent improvements in air transport have increased the opportunities to expand its use in marketing a number of agricultural perishables. These improvements include larger and faster planes with lower operating costs, and improved containerization and cargo handling methods. The speed of air transport and improved handling techniques should provide savings in packaging, handling, and refrigeration costs and reduce product and quality losses. Research should be expanded to find ways to use this new technology to do a better job of transporting perishable farm products and to include better service in transshipments and protection at terminals.

Improved coordination of Transport Services

Costs and efficiency in marketing agricultural and food products depend to a very large extent upon how effectively the transport requirements of the physical distribution system are met. Poor coordination of the services of the different transport modes lowers the utilization rates for equipment and facilities, increases transport costs, and delays marketing and processing schedules. Operations research techniques afford the means of determining the most efficient means for coordination of the services of the different transport modes to meet the needs of the marketing system. Research to find ways to improve coordination of transport services for agricultural products and farm supplies should be undertaken.

Future Demand for Florists and Nursery Crops

Economic research should be continued to estimate the future demand for floral and nursery crops. Such information and analyses are needed for long-range planning to enable producers to more adequately meet the changes in demand resulting in part from the "beautify America" program. Particular attention should be given to estimating demand based on statistical series such as population, income, housing starts and other economic factors.

Consumer Preference for Nursery and Floricultural Products

Marketing of cut flowers and potted plants through mass market outlets is having a tremendous impact on market structure and marketing practices for these products. Further information is needed concerning household consumers' opinions of and preferences for cut flowers, potted plants, and landscaping materials, and the decision-making process involved in purchase or non-purchase of the products. The effects of specific marketing techniques on consumer purchases of nursery and floricultural products should also be investigated.

Marketing Methods

Research should be undertaken to provide a base for more orderly and effective consolidation of operations of existing marketing organizations for fruits and vegetables in order to improve quality, expedite distribution, increase return to growers and reduce cost to consumers.

Changes in Structure and Practices of Assembly Markets for Fresh Fruits and Vegetables

The evolution in marketing practices has substantially altered both the functions and importance of the marketing agencies engaged in the distribution of fresh fruits and vegetables. This has also had an impact upon the assembly phase in marketing fruits and vegetables. Research is urgently needed to determine the nature of changes in the structure and practices of these agencies to allow an evaluation of the extent to which they presently contribute to an efficient marketing system. This information will assist in efforts to establish a more efficient marketing system for fresh fruits and vegetables.

Consumer Preferences

The Committee recommends consumer preference studies be initiated to cover a wider selection of horticultural crops and the survey be expanded to include preferences by ethnic, income, and geographic groups as a guide to better marketing.

Economic Factors in Fresh Fruit and Vegetable Distribution

There is an urgent need to increase the marketing efficiencies for fresh fruits and vegetables. An economic analysis of the distribution of fresh fruits and vegetables and specialties and the impact of changing technologies on grower return and consumer costs should be initiated.

Seasonal Processing Research

Research should be conducted for better utilization of facilities currently used by processors on a seasonal basis to enhance grower return and reduce consumer costs.

Labor Requirements for Harvesting Horticultural Crops

There is an urgent need to evaluate the impact of restricted and higher cost labor on grower return, consumer cost, and product quality. Correspondingly better recommendations for possible solutions should be provided, and these must include better judgements on labor requirements in advance of critical harvest periods.